Deep Temporal Analysis of Clinical Signals for PCOS Detection

Submitted by

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PROFORMA FOR SYNOPSIS:

1. Introduction: Given purpose of Research
2. Research Aims and Objectives
3. Review of Literature
4. Research Methodology & Materials
5. Ethical considerations (wherever applicable)
6. Expected outcome of the proposed work
7. References in standard format

Jastinder Kaur

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3.	**Remarks:** **Name & Signature of Head of Department:** (wherever applicable)
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ANNEXURE – B

DECLARATION

I. I, Jastinder Kaur, hereby declare that all the statement made in this application are true, complete and correct to the best of my knowledge and belief and in the event of any information being found false or incorrect or any ineligibility being detected before or after the registration for Ph.D. My candidature is liable to be cancelled and legal action may be initiated against me.

II. I have deposited the required fee, as notified by the University regularly.

III. I have noted that if my application is found incomplete / defective, the same is liable to be rejected summarily and no correspondence will be entertained in this regard.

IV. I have read and agree with the University Revised Ph.D. Ordinance No. 14 and UGC Regulation – 2009, and all the Amened Regulations or newly passed Regulations by the UGC on or before below mentioned date.

Jastinder Kaur

Place: Jaipur

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1. INTRODUCTION

One of the most common endocrine disorders in the woman of the reproductive age, polycystic ovary syndrome or PCOS [1] has a cluster of symptoms involving abnormal menstrual periods, high androgen levels, and the polycystic appearance of ovaries, which pose great challenges on both physical and mental health status for women. Beyond being reproductive, such condition is deeply linked to critical comorbid conditions including type 2 diabetes mellitus, cardiovascular diseases, and obesity. In such a scenario, PCOS very often remains undiagnosed and poorly managed, which leaves an urgent unmet need to have more stringent and reliable tools for diagnosis.

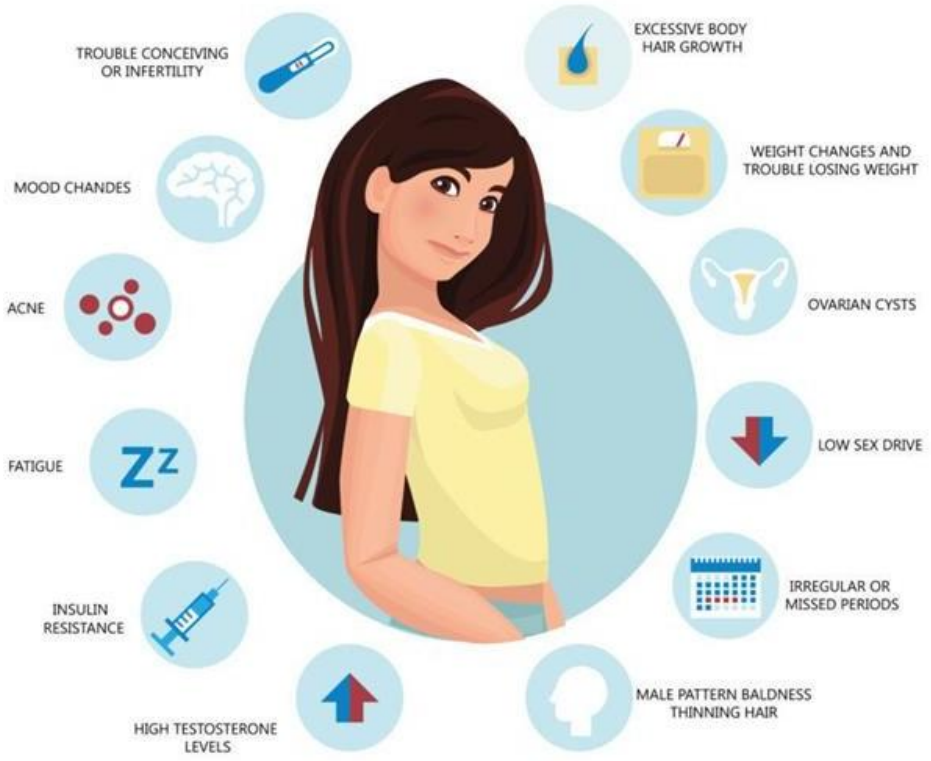

Figure 1. PCOS Symptoms

Prevalence of PCOS in India has been alarmingly high, cutting across 9% to 36% among women in the age group of women of reproductive ages using slightly different diagnostic criteria. A more recent study reported clinical symptoms among nearly one out of five among urban Indian women [2]. This condition is increasingly reported

due to the changes in lifestyles, urbanization, and stress that trigger the problems. However, there still is a lack of awareness of PCOS in rural and semi-urban areas, which complicates this situation because most of the cases are not diagnosed until such advanced complications set in. Such inequalities stress the need for early diagnosis and intervention in order to minimize risk in the long run.

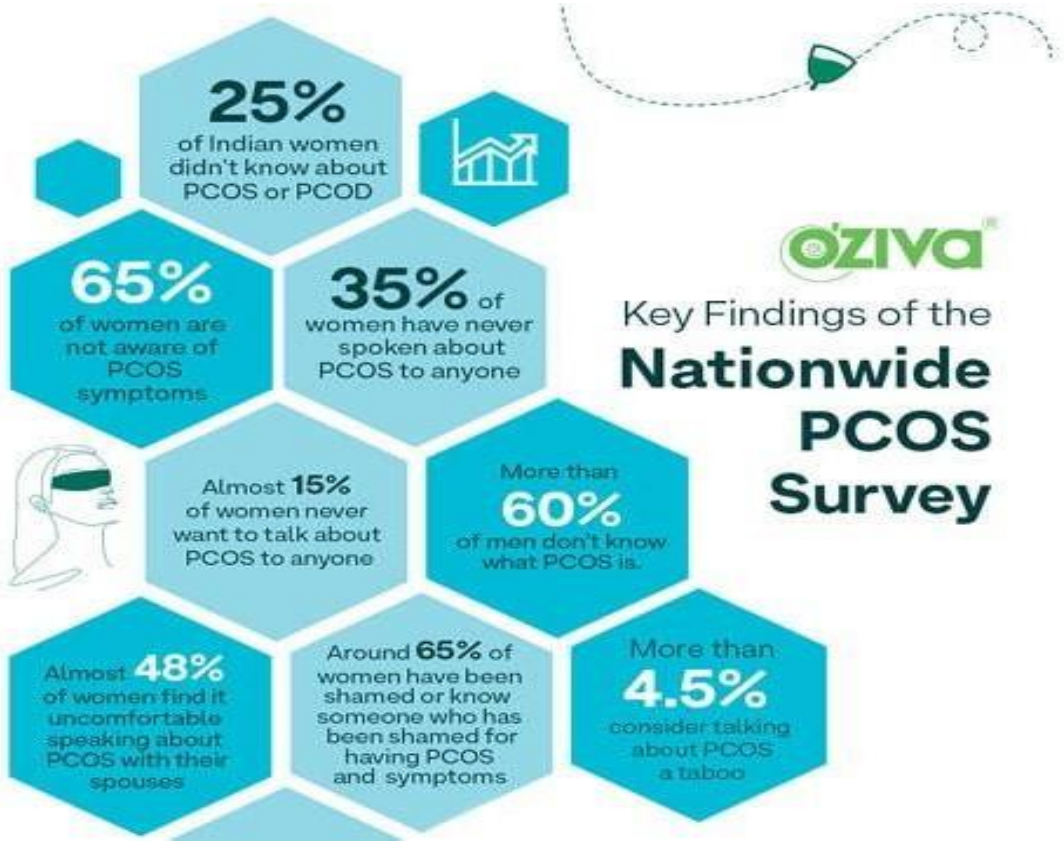
25% of Indian women didn't know about PCOS or PCOD
65% of women are not aware of PCOS symptoms
35% of women have never spoken about PCOS to anyone
Almost 15% of women never want to talk about PCOS to anyone
More than 60% of men don't know what PCOS is.
Almost 48% of women find it uncomfortable speaking about PCOS with their spouses
Around 65% of women have been shamed or know someone who has been shamed for having PCOS and symptoms
More than 4.5% consider talking about PCOS a taboo
oziva
Key Findings of the
Nationwide
PCOS
Survey

Figure 2. India Awareness Statistics of PCOS

Despite the medical research, PCOS remains a challenging diagnostic process. Classic diagnostic methods alone, such as clinical history, hormonal tests, and ultrasound imaging, are inadequate to describe the complexity of this disease because its nature is quite multifactorial [3]. Variability in hormonal levels for different time periods, inter-patient variability, and diagnostic criteria that are not consistent, namely, Rotterdam, NIH, and AES also increase diagnostic ambiguity. These methods are also highly subjective because they depend on clinician interpretation, thereby increasing the risk of misdiagnosis or delayed diagnosis. Current approaches neglect the potential leverage of time-series patterns, such as hormonal fluctuations and metabolic markers, which can be used to derive more meaningful inferences about the course of the disorder.

The main challenges highlight the need for new, data-based diagnostic solutions: advanced machine learning techniques, tailored in particular to time-series data, may provide deeper and more detailed insights into the nature of PCOS. An innovative approach to these issues is brought by Attention-Driven Recurrent Neural Networks (RNNs) [4] that can unlock and discover critical patterns and dependencies between sequential data streams, thus enabling early detection of PCOS while providing personalized management strategies.

Significance of the Research-

This proposed research shall revolutionize PCOS diagnosis with the aid of Attention-Driven Recurrent Neural Networks in time-series data. PCOS [5], an extremely prevalent endocrine disorder, typically has inefficiencies and delays as well as depends more on the judgment of clinical personnel. This study addresses those problems by bringing forth a data-driven framework highlighting temporal patterns in hormonal fluctuations, metabolic changes-a vital component necessary for proper diagnostics that is somewhat missing in many conventional methods. With enhanced diagnostics accuracy and explainability, it helps in providing better clinical judgment but also is likely to give a better improvement in early diagnoses that would lessen the risks with PCOS which includes infertility and diabetes and potential cardiovascular diseases as well. The proposed system is highly scalable and also has the capability to be fitted into other telemedicine systems. Thus, it would be easily accessible in underserved regions, especially in India. The use of attention mechanisms provides better explainability, enhancing the trust of clinicians with AI-based diagnostic tools in healthcare [6].

Research Questions:

1. Can Attention-Driven RNNs enhance the diagnosis accuracy of PCOS by identifying the primary temporal patterns in time series?
2. Can this method take into account the dynamic nature of hormonal fluctuations and metabolic indicators, which are key to the diagnosis of PCOS?
3. What influence does the introduction of attention mechanisms have on the interpretability and trustworthiness of the model for clinical usage?
4. How might this framework be developed to scale and adapt well for resource-poor environments like rural and deprived areas?
5. Can the model be validated on real-world datasets to demonstrate its reliability and applicability across different clinical scenarios?
6. How does the use of an Attention-Driven RNN [7] framework enhance early detection, intervention, and overall patient outcomes for women with PCOS?

2. RESEARCH AIMS AND OBJECTIVES

2.1 Research Aims-

This paper aims to fundamentally transform the PCOS diagnostic process through the application of advanced machine learning methods, such as Attention-Driven RNNs [8], to time-series data for analysis. It hopes to address existing challenges in the diagnosis of PCOS, like reliance on subjective clinical evaluation and insufficient focus on temporal patterns, with a robust data-driven framework to improve the accuracy and interpretability of diagnostics.

A key goal of this work is exploring whether time-series analysis could add something to the capture of the dynamic nature of hormonal fluctuations, metabolic indicators, and other sequential markers critical in PCOS diagnosis [8]. Thus, by incorporating attention mechanisms within RNNs, the study focuses on the most relevant temporal features and enables the model to discern subtle variations that may be indicative of the syndrome. This will not only make the results more accurate but would also enhance the understanding of the evolution process of PCOS and its relation with the related physiological changes.

Another major objective is to develop an evolving diagnostic framework that is scalable and adaptable enough to be used throughout various clinical settings, extending to developing areas. Because the disease PCOS [9] is extremely common in India and in many other regions where the infrastructure is generally not well developed, the paper aims to make a model that is both accessible and feasible for usage as widely as possible. Moreover, integration with telemedicine platforms or mobile applications shall assist in democratizing access to reliable diagnostic tools toward women as well as their healthcare providers.

In addition to improving diagnostic output, the research further intends to enhance the interpretability of models learned under machine learning towards clinical application. The fact that attention mechanisms themselves are informative of the relevant time points and features involved in making diagnostic decisions creates a more transparent and trustworthy system for clinicians. Such interpretability is indispensable in building confidence in AI-driven solutions and in promoting their use in clinical settings [10].

Finally, the study will contribute to a more general body of knowledge of research in women's health by showing the potential of the use of sophisticated machine learning algorithms to approach complex, multifactorial disorders such as PCOS. Establishing a solid basis for the use of Attention-Driven RNNs [11] in medical time-series data, it prepares the ground for further breakthroughs in diagnosis and treatment of various diseases, hence promoting the field of precision medicine.

2.2 Research Objectives

The objectives of research are as follows,

1. To Undertake a comprehensive review of literature identifying the diagnostic methodologies for PCOS, weaknesses present in the diagnosis, and the ability of sophisticated deep learning algorithms including RNN and attention mechanism may offer to health care.
2. Innovative Development of a novel diagnostic framework called Attention-Driven RNN. The model should be able to take time series information and highlight and focus on pertinent patterns for diagnosis of PCOS.
3. Optimizing the diagnostics performance: It will improve the key metrics, such as precision, recall, F1-score, and overall accuracy, while keeping the reliability and efficiency of the diagnosis for PCOS.
4. For validating the framework on real-world datasets: Test the proposed model on authentic datasets regarding PCOS for validating the reliability and its applicability to different clinical scenarios.
5. To ensure scalability and accessibility, resource-constraining environment and telemedicine platforms; that easily could be implemented as widely as possible.
6. For early detection and intervention: Ease the accuracy and promptness of diagnostic appraisal of PCOS to enhance patient outcomes and minimize the dangers of complications within the long term.

3. REVIEW OF LITERATURE

Umapathy, S. et al., (2024) [12]: The study presented a hybrid approach for follicle detection based on the integration of YOLOv8 for object detection and GLCM for extracting texture-based features. The features were classified using ML and DL classifiers. Based on this, the study reported excellent diagnostic accuracy with a custom model, F-Net, as 95% on Dataset 1 and 97.5% accuracy on Dataset 2, which holds promise as an efficie nt diagnostic tool for PCOS.

Praneesh, M., et al. (2024) [13]: Using the VGG19 Net in conjunction with ML algorithms, this work was able to obtain 96% accuracy in classifying ovarian ultrasound images related to early detection of PCOS. The model was superior to conventional approaches like Random Forest (RF) with 94% accuracy and Support Vector Machines (SVM) with 92%, highlighting high outcomes of advanced deep learning techniques.

Prathibanandhi, J., & Vimala, G. A. G. (2024) [14]: A CNN-based approach that combined image pre-processing, segmentation, and classification steps for developing a PCOS diagnosis methodology was proposed. All those metrics such as accuracy, recall, precision, and F1-score were outperformed by the other models with this approach.

Rao, D., et al. (2024) [15]: The proposed deep learning model used the hyperparameter optimization using Optuna, which achieved a reliability of 93.55% in the prediction of PCOS from health data. Precision diagnostic s were greater than traditional ML techniques, focusing on the use of optimization frameworks in DL.

Alamoudi, A., et al. 2023 [16]: A fusion model, which combined ultrasound and clinical data, achieved a detection accuracy of 82.46% for PCOS. For image analysis alone, the Inception model had a higher accuracy of 84.81%, which signifies the importance of integrating multi-source data for more robust diagnostics.

Erdemir, E., & ERDA, Ç. B. (2023) [17]: The study used DenseNet-201 as the backbone by incorporating data augmentation techniques with a remarkable achievement in the detection of PCOS from ultrasound images, which is 99.48%. This is further enhanced through transfer learning and image preprocessing, indicating its effectiveness in improving diagnostic performance.

Abouhawwas h, M., et al. (2023) [18]: Using the tri-stage feature selection process involving CNN, achieved

98.67% accuracy and 97% precision to classify PCOS using biochemical data as well as imaging data; it, thus, demonstrates that combining different types of modalities and feature selection techniques can aid in the effective detection process.

Gethsiya Raagel, K., et al. (2023) [19]: The methodology included using Wiener filtering for pre-processing the image in combination with CNNs in detecting follicles with an outstanding result of 97.63% accuracy, whereas PCOS classification from ultrasound image segments resulted with 77.81% and left scope to further improve it using segmentation-based models.

Nagodavithana, B., & Ullah, A. (2023) [20]: It compared several deep learning models for classifying healthy ovaries and ovaries affected by PCOS. The Custom ResNet-50 obtained 96.7% accuracy, while a standard CNN model scored 99% accuracy, proving the effectiveness of customized architectures for PCOS diagnosis.

Kangasniemi, et al. (2022) [21]: analysed the use of AI technology to assess endometrial immune cells and to identify differences between menstrual cycle phases and women with PCOS compared with non-PCOS controls. The study argues that it is a challenge to analyze endometrial histology due to technical problems and lack of well-phenotyped samples. These can be overcome by AI, which would contribute to the comprehension of the immune cell landscape in PCOS and further advance the discriminative power of diagnostic measures.

Table 1. Literature Review Findings

Author Name (Year)	**Main Concept**	**Findings**	**Limitations**
Umapathy, S., et al. (2024) [12]	Hybrid approach for follicle detection using YOLOv8 and GLCM	Custom model F-Net achieved **95% accuracy** on Dataset 1 and **97.5% accuracy** on Dataset	Relies on a custom model, and generalizability across datasets

		2 for PCOS detection.	could be further tested.
Praneesh, M., et al. (2024) [13]	Using VGG19 Net with ML algorithms for PCOS detection in ovarian ultrasound Images	Achieved **96% accuracy**, outperforming **RF (94%)** and **SVM (92%)**.	Relies on a single deep learning model, and real-world dataset performance needs validation.
Prathibanandhi, J., & Vimala, G. A. G. (2024) [14]	CNN-based approach combining image pre-processing, segmentation, and classification for PCOS diagnosis	Outperformed other models in accuracy, recall, precision, and F1-score.	Requires robust data for segmentation, and results may vary with dataset size and quality.
Rao, D., et al. (2024) [15]	Deep learning model with Optuna hyperparameter optimization for PCOS prediction	Achieved **93.55% reliability** in PCOS prediction, with better precision diagnost ics than traditional ML.	May need further refinement for real-world deployment and external validation.

Alamoudi, A., et al. (2023) [16]	Fusion model combining ultrasound and clinical data for PCOS detection	**82.46% accuracy** for PCOS detection, and **84.81%** for image analysis using Inception.	Lower accuracy for fusion model, and may require better integrat ion techniques for clinical data.
Erdemir, E., & ERDA, Ç. B. (2023) [17]	DenseNet-201 with data augmenta t ion for PCOS detection from ultrasound images	**99.48% accuracy** with the use of transfer learning and image preprocessing.	May require large, diverse datasets for further generalization and real-world applications.
Abouhawwash, M., et al. (2023) [18]	Tri-stage feature selection process with CNN for PCOS detection	**98.67% accuracy** and **97% precision** for classifying PCOS using biochemical and imaging data.	May be complex and computationally expensive, requiring further validation.
Gethsiya Raagel, K., et al. (2023) [19]	Using Wiener filtering and CNN for follicle detection and PCOS classification	**97.63% accuracy** for follicle detection, but **77.81% accuracy** for PCOS classifica t ion from segmented images.	Segmentation challenges affecting overall performance for PCOS

			classification.
Nagodavithana, B., & Ullah, A. (2023) [20]	Comparison of deep learning models for classifying healthy and PCOS-affected ovaries	**96.7% accuracy** with **Custom ResNet-50** and **99% accuracy** with CNN for PCOS classification.	Model performance may vary with different dataset conditions and real-world scenarios.
Kangasniemi, M. H., et al. (2022) [21]	AI technology for analyzing endometrial immune cells in PCOS and non-PCOS women	AI can aid in analyzing endometrial histology and identifying differences between menstrual phases and PCOS.	Lack of well-phenotyped samples and technical challenges in analyzing histology.

Key Findings

1. **High Accuracy in Diagnosis Using State-of-the-Art Deep Learning:** Deep learning models especially CNN-based, have also been established for improving the diagnostic accuracy of PCOS. Umapathy et al. 2024) and Praneesh et al. 2024) realized an accuracy ranging from 95% to 97.5% using hybrid model with combining deep learning & texture-based feature [12,13]. Again, Erdemir & ERDA, 2023 showed the DenseNet-201 method through the transfer learning approach and achieving accuracy 99.48% [17].
2. **Hybrid Models:** Hybrid models, that is, which use more than one technique, such as CNNs in combination with GLCM, YOLOv8, and VGG19, produce the better outcome. The authors vindicated the strengths of the combination of biochemical data and imaging are realized with the Abouhawwash et al. 2023. An accuracy level of 98.67% is achieved from the three-stage feature selection process with the precision level of 97% [18].
3. **Optimization Techniques:** Optuna- An application of hyperparameter optimization frameworks improves the deep learning model towards better performance. Rao et al. (2024) achieved 93.55% reliability with such similar techniques on health data related to the prediction of PCOS [15]. Significance of Data Integratio n Types: Ultrasound, clinical, and biochemical information can be fused to improve accuracy and robustness in diagnosis simultaneously. Alamoudi et al. (2023) presented that the merging of ultrasound data with clinica l results produced a 84.81% accuracy rather than image processing alone at a rate of 82.46% [16].
4. **Transfer Learning and Data Augmentation:** As mentioned in the paper of Erdemir & ERDA, 2023, these transfer learning and data augmentation applications boost the performance of the model and hence with limited images, it is possible to achieve good performance of the model. Hence, with the dense accuracy rate of 99.48% by DenseNet-201 [17].

Research Gaps:

1. **Possible improvements for Segmentation-Based Models:** Although most models had excellent detection accuracy, segmentation-based models mostly needed additional enhancement. For example, Gethsiya Raagel et al. (2023) obtained 97.63% accuracy in follicle detection but only 77.81% for PCOS classification from ultrasound segments, thus showing a difference in the accuracy of segmentation [19].
2. **Limitations of Multi-Source Data Integration:** The fusion of multi- modal data, such as ultrasound images and clinical or biochemical data, is very challenging due to issues like data compatibility and preprocessing. Although Alamoudi et al. (2023) achieved promising results, the complexity in fusing different types of data remains a major problem [16].
3. **Dependence on Good Quality Data:** It requires high-quality well-annotated datasets to have the success of deep learning models. Models based on health data such as Rao et al. (2024), the availability of data and its quality limits its generalizability and model's performance in the real-world application [15].
4. **Interpretability of Complex Models:** Though deep learning models are extremely powerful, they are not interpretable. If such systems are to be applied for medicine-diagnosis like that of PCOS, clinicians would require absolute explanation for the predictions made by these models. Working around this challenge would increase confidence and adoption of AI-based diagnosis systems in healthcare.
5. **Possible Overfitting with Custom Architectures:** Some other custom architectures are also being built, such as Nagodavithana & Ullah's (2023) model based on ResNet-50 with an accuracy of 96.7%, which suffers sometimes from overfitting and does not generalize very well across many datasets. Fine-tuning of the model along with cross-validation might improve generalization [20].

4. RESEARCH METHODOLOGY AND MATERIALS

This investigation method on an attention-driven RNN for the diagnosis of PCOS incorporates a structured framework, from data acquisition to preprocessing and development to validating. It harmoniously puts together machine learning elements with those from medical diagnostics towards developing an intelligent system able to provide the most accurate possible time-series based diagnosis for the disorder PCOS [22].

1. **Data Collection**

   First, the required datasets for the diagnosis of PCOS would be obtained based on the proposed methodology. There would generally be two types of data that would feature in this research study.

   This might include, but is not limited to, changes in the level of LH and FSH hormones [23] over time, variability in the level of insulin and testosterone with time, metabolic indicators, or other health measures such as blood pressure, weight, and glucose. Ultrasound or Imaging Data: The data set for extracting ultrasound features is based on PCOS that may sometimes elicit cystic changes in the ovaries or ovarian enlargement or any other similar abnormality.

   Source data to be acquired from public data sets of PCOS or from any clinical data collaborative projects. It should have samples of both healthy and PCOS [23] affected so that diversity and generalization are provided to the model.

2. **Data Preprocessing**

   Good quality and uniformity in data need preprocessing and cleaning before feeding it into the Attention-driven RNN model [24].

   - **Normalization and Standardization:** The continuous data are scaled to a range, such as hormonal levels and other metabolic indicators, as otherwise scale differences might arise.
   - **Handling Missing Values:** Missings are enormously prevalent in medical datasets. Mean imputation and forward fill with excluding rows having too many missing values will be used to address this [25].

- **Data Augmentation:** These are ultrasound images. Thus, methods to perform augmentation might consist of rotation, flipping, and scaling to artificially add to the size and increase diversity of the dataset. This increases model robustness [26].
- **Time-Series Transformation:** The time-series data will be transformed into appropriate forms, like sequences, for the RNNs. Noisy or outlier points in data shall be smoothed through statistical techniques, say, by moving averages or interpolation [27].
- **Feature Extraction:** In ultrasound images, relevant features, like cyst formation, ovarian size, etc., will be extracted using deep learning models, like CNNs [28].

3. Model Development

Major conceptual use of methodology A major concept of the methodology is that it will use an attention-driven RNN for diagnosis to PCOS [29]. The model, here it's going to capture the dependencies, however the dependencies are covered up with critical intervals or with time dependencies while using RNN.

- **RNN Architecture:** The RNN is used to model the time series data mainly if the fluctuations of hormones and metabolic changes resulting from PCOS are sequence in nature, and this can be accomplished using LSTM networks or GRUs [30].
- **Attention Mechanism:** An attention mechanism in the RNN ensures that the model learns to pay attention to the important time points of the time series. It tends to focus more on such features and time periods which would be more informative for the diagnosis.
- **Hybrid Model (Optional):** When there are ultrasound images alongside times-series data, the model will become a Hybrid in which CNNs replace image processing and RNNs replace the time-series analysis. Spatial features extracted by CNNs from ultrasound images and from temporal data will be handled by RNN layers.
- **Activation and Loss Functions:** ReLU function would be used as activation functions for hidden layers while either the sigmoid or softmax function, depending on the type of classification to be applied. For example, for binary classification, like PCOS and normal, a cross-entropy might be used [31].
- **Optimizations:** Adam or RMSprop are some other optimization algorithms that could have been

minimized over the loss function so as to better improve the performance of the model.

4. Training the Model and Testing

The model shall subsequently be trained and tested.

- **Training:** Training data is provided for the inductive learning process. Conventional in use, 80% of the entire corpus may be used for training purposes, while 20% can be used for validation; however, cross-validation, similar to k-fold, is also done where the performance of the model on various subsets of the data is being measured.
- **Hyperparameter Tuning:** All these hyperparameters like the learning rate, batch size, and number of epochs would be set with grid search or random search to determine the best hyperparameters.
- **Evaluation metrics:** These are some of the evaluation metrics which can check the performance of this model.
- **Accuracy:** This is the ratio of correctly classified instances (PCOS vs. healthy).
- **Precision:** This is the ratio of true positive predictions.
- **Recall:** This is the ratio of the true positive, which has been classified correctly.
- **F1-score:** The very balanced measure for precision and recall; it especially shines in an imbalanced set of data.
- **Comparing the Models:** A comparison of how well the Attention-Driven RNN performs versus other baselines, such as RNN, SVM, and k-NN; in that regard, it vividly manifests effectiveness of attention in detecting useful patterns.

5. Validation and Testing

- **Testing:** It also makes it possible to establish the generalizability of the model and if it is helpful in real-world applications by testing against an unseen test set, which could typically be 20% of the whole dataset or a completely new test set.
- **Cross-validation:** Further testing will be through cross-validation so that the performance is not good only for this one subset but generally consistent over all subsets.

6. Deployment and Scalability

After having passed all the validation checks, the remaining procedure would be one of deployment and scalability in bringing the model into use.

- **Deployment:** this model will be placed in a friendly user platform, which may include a mobile application or telemedicine system where health care providers and patients are provided with remote access to the diagnostic tool
- **Real-time Prediction:** The system will, therefore, enable it to process real-time data, so as to keep tracing the trends in the levels of hormones for instance, hence in a position to make timely diagnosis.
- **Adaptability for Telemedicine:** The system will be configured to work properly in resource-scarce environments also, so amenable to practice in remote or primary healthcare centers in which the classic methods of testing are not available.

5. Ethical Considerations

Ethical Issues: It will ensure maintaining patient confidentiality as well as safety of the research data in compliance with the medical data privacy and ethics concerning AI in health-related applications.

Explanations: This attention mechanism would give insights into the decision-making of the model. Clinicia ns will understand why the model diagnosed that patient with that diagnosis, which is crucial for the clinical adoption. This complete methodology aims at the creation of a highly accurate and scalable cutting-edge data-driven solution for the diagnosis of PCOS that would potentially help improve early detection and long-term care of patients.

This research, therefore, takes into consideration ethical requirements for the collection, handling, and processing of medical data related to diagnosis in PCOS. Since the data is that of time-series on hormonal and metabolic levels, and also ultrasound images, careful measures must be provided to ensure privacy, confidentiality, and adherence to the ethical guidelines of handling such data. It should note that if clinical or patient-derived datasets are utilized, they should be obtained from public repositories or through IRBs ethical approvals at the respective institution where they were generated. Any such PII should also be de-identified to avoid any breach in terms of patient privacy compliance with GDPR and HIPAA.

Moreover, concerns over bias arise when handling AI-based diagnostics. A diverse and all-inclusive dataset is important to prevent algorithmic bias, which results in false or biased diagnoses. If there are humans being recorded, then data collection will require informed consent, whereby study participants should be informed of the purpose of the study, its risks and benefits. This adds a demand for model interpretability and transparency, and thereby the demand states that AI-driven predictions have to be trustworthy with proper interpretations toward healthcare providers. Therefore, in order to add solutions to all these ethical demands, this paper deals with its ethical issues about responsible AI in PCOS diagnostics and maintains more fairness, inclusion, and trustworthiness during its implementation.

6. Conclusion-Expected outcomes and potential contributions.

This research will revolutionize the diagnosis of PCOS through an Attention-Driven Recurrent Neural Network (RNN) to analyze time-series hormonal and metabolic data combined with ultrasound imaging. The results of this research should be a highly accurate, robust, and scalable model that would improve early detection and diagnosis of PCOS. The model will detect temporal dependencies in fluctuations of hormones and metabolic variations more precisely than standard diagnostic techniques. It is expected that the emphasis mechanism in the RNN will contribute to an improvement in interpretability: via drawn-out most relevant time points in patient data, thus enhancing clinical decisions by healthcare professionals. A hybrid model that incorporates CNNs for the analysis of ultrasound images might make it even more accurate in diagnostics since both spatial and temporal features would be considered.

The possible outcome of this study affects several realms of activity. In health, improved diagnostic accuracy means early intervention and personalized treatment plans for PCOS-afflicted subjects. This is especially critical in resource-scarce areas with restricted access to specialized gynecological care, such as rural areas. From a technological standpoint, the study advances the field of explainable AI in medical diagnostics, allowing doctors to understand and trust AI-driven recommendations. Additionally, the findings from the research may be used to inform public health policies in that it calls for more extensive screening programs and more accessible diagnostic tools. Future developments could also translate the model to other endocrine disorders featuring time series characteristics, thereby establishing a significant scope for medical research applications.

However, the study has some limitations. First, it is generally challenging to obtain high-quality medical datasets due to missing values, noise, and inconsistencies in real-world clinical data. Although some form of bias is bound to remain even after applying data imputation techniques. The proposed model will have limited generalizability because the training is done on a limited dataset, thereby not capturing all population-wide variations in PCOS manifestations. AI-based black box models may require increasing resistance from

medical adoption since clinicians will not easily embrace diagnostics through AI without an explanation of the processes leading to their predictions. The computational constraint, especially in resource-limited settings, will limit the massive implementation of the proposed framework.

Despite these challenges, this research could be a stepping stone towards AI-enabled advancement in reproductive health, offering a scalable and interpretable solution for the diagnosis of PCOS while filling the present gaps of conventional clinical practice.

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8. Timeline Diagram:

Phases	1-6 Months	7-12 Months	13-18 Months	19-24 Months	25-30 Months	31-36 Months
Phase I	Define Research Objectives and Questions Conduct a Comprehensive Literature Review Synthesize and Analyze Literature					
Phase II		Select Research Methodology Data Collection Initial Data Analysis and Method Refinement				
Phase III			Model Selection Model Training Model Evaluation			

Phase IV				Testing and		
Phases	1-6 Months	7-12 Months	13-18 Months	**19-24 Months**	25-30 Months	31-36 Months
	Define Research Objectives and					
	Questions					
Phase	Conduct a Comprehensive					
I	Literature					
	Review Synthesize and					
	Analyze					
	Literature					
		Select				
		Research Methodology				
		Data				
Phase						
II		Collection Initial Data				

		Analysis and				
		Method Refinement				
			Model Selection			
Phase			Model			
III			Training Model			
			Evaluation			
Phase **IV**				**Testing and**		
Phases	1-6 Months	7-12 Months	13-18 Months	**19-24** **Months**	25-30 Months	31-36 Months
	Define Research Objectives and					
	Questions					
Phase	Conduct a Comprehensive					
I	Literature					
	Review Synthesize and					
	Analyze					

	Literature					
		Select				
		Research Methodology				
		Data				
Phase						
II		Collection Initial Data				
		Analysis and				
		Method Refinement				
			Model Selection			
Phase			Model			
III			Training Model			
			Evaluation			
Phase IV				**Testing and**		
Phases	1-6 Months	7-12 Months	13-18 Months	**19-24 Months**	25-30 Months	31-36 Months

	Define Research Objectives and					
	Questions					
Phase	Conduct a Comprehensive					
I	Literature					
	Review Synthesize and					
	Analyze					
	Literature					
		Select				
		Research Methodology				
		Data				
Phase						
II		Collection Initial Data				
		Analysis and				
		Method Refinement				

			Model Selection			
Phase			Model			
III			Training Model			
			Evaluation			
Phase IV				**Testing and**		
Phases	1-6 Months	7-12 Months	13-18 Months	**19-24 Months**	25-30 Months	31-36 Months
	Define Research Objectives and					
	Questions					
Phase	Conduct a Comprehensive					
I	Literature					
	Review Synthesize and					
	Analyze					
	Literature					
		Select				

		Research Methodology				
		Data				
Phase						
II		Collection Initial Data				
		Analysis and				
		Method Refinement				
			Model Selection			
Phase			Model			
III			Training Model			
			Evaluation			
Phase IV				**Testing and**		

				Optimization Integration		
Phase V					External Validation Results Analysis Manuscript Preparation	
Phase VI						Thesis writing and submission

IEEE Conference Paper Acceptance

2nd International Conference on Machine Learning and Autonomous Systems (ICMLAS 2025)

10-12, March 2025 | https://icmlas.com

Acceptance Letter

PAPER ID - ICMLAS-01

Dear Author

Hearty Congratulations!

On behalf of the Organizing Committee of the **2nd International Conference on Machine Learning and Autonomous Systems (ICMLAS) 2025,** we are delighted to inform you that your paper has been accepted for presentation and inclusion in conference proceedings.

Paper Details are as follows:		
Title	:	*PCOS Diagnosis through Time-Series Analysis Using RNN with Attention Mechanism*
Author(s)	:	*Jastinder Kaur, Raj Sinha*
Registration deadline	:	*January 16, 2025*

Your research manuscript has been accepted after the peer-review process of ICMLAS-2025 for oral presentation and publication in ICMLAS-2025 proceedings. We cordially invite you to register for the conference and present your paper orally during the online event, which will be held from **March 10-12, 2025.** We congratulate you on being successfully selected for the presentation of your research work in our esteemed conference.

Conference Chair
ICMLAS – 2025

ICMLAS 25

ANNEXURE – C

(On University Letterhead)

Directorate of Research & Development (DRD) where Research work will be carried out:
(wherever applicable)

The Synopsis of …….Mrs. Jastinder Kaur…….is in order, approved and recommended by DRD and forwarded to Dean or Director of Faculty of..... for consideration of registration for the degree of Doctor of Philosophy in Improving Polycystic Ovary syndrome (PCOS) Diagnosis with Attention Recurrent Neural Networks (RNNs)

Place:
Date:

Signature with Seal of the Director, DRD

REGISTRAR
Jayoti Vidyapeeth Women's University
Jaipur

ANNEXURE – D

(On University Letterhead)

Dean/Director of Faculties

Recommendation of the Dean or Director, Faculty of ……...……

The Synopsis of Shri / Smt. / Ku ..... is in order, approved and recommended by Director, DRD and forwarded to UREC/RAC for consideration of registration for the degree of Doctor of Philosophy in the ..... (Topic).

Place: **Signature with Seal of the Dean or Director of Faculty of …….**

Date:

Place: **Signature with Seal of the President, Jayoti Vidyapeeth Women's University, Jaipur**

Date:

REGISTRAR
Jayoti Vidyapeeth Women's University
Jaipur

ANNEXURE – E

(On University Letterhead)

University Research Evaluation Committee (UREC) / Research Advisory Committee (RAC)

Recommendation of the Chairman, UREC/RAC…… (*Name of Institute)*……

The Synopsis of Shri / Smt. / Ku.....is duly approved on the recommendation of for registration in the program Doctor of Philosophy in the ….....(topic).

Place:
Date:

Signature with Seal of the Chairman, UREC/RAC

Registrar
Jayoti Vidyapeeth Women's University
Jaipur, Rajasthan

REGISTRAR
Jayoti Vidyapeeth Women's University
Jaipur